REMARKS

Claims 1-14 are provisionally rejected under the judicially created doctrine of obviousness double patenting as being unpatentable over claims 1-3 of co-pending Application No. 10/717,855. Applicants submit herewith a Terminal Disclaimer to overcome this provisional rejection.

Prior Art Rejections

The Office Action includes the following six prior art rejections:

(1) Claims 1-14 for anticipation by JP 11-021,197

(2) Claims 1, 3, 5 and 10 for anticipation by U.S. Patent Publication No. 2004/0099205 to Li et al.

(3) Claims 1, 4, 5 and 11 for anticipation or obviousness over U.S. Patent No. 6,332,922 to Sakuma et al.

(4) Claims 1, 4, 5 and 11 for anticipation or obviousness over U.S. Patent No. 6,673,150 to Garibin et al.

(5) Claims 1-14 for obviousness over JP '197

(6) Claims 1-14 for obviousness over the combined teachings of the Li application and JP '197

Applicants respectfully traverse these rejections for the following reasons.

The present invention is directed to an as-grown single crystal of alkaline earth metal fluoride that is produced by a single crystal pulling method. The crystal has a straight barrel length of not less than 17 cm and a light transmittance of not less than 80% when measured at a wavelength of 632.8 nm. Contrary to the assertions in the Office Action, an alkaline earth metal fluoride crystal grown by a single crystal pulling method and having a light transmittance at 632.8 nm of not less than 80% is not inherent to the crystals and methods of producing those crystals disclosed in the cited references.

While the production system shown in Fig. 1 of the present application is not a definitive limitation in the claims, certain features of a system for pulling crystals is important in producing an alkaline earth metal single crystal by a single crystal pulling method to achieve a crystal with a length of at least 17 cm and light transmittance of at least 80% at 632.8 nm. As detailed below and demonstrated by the accompanying Declaration

Under 37 CFR §1.132, not all single crystal pulling systems result in a crystal having the claimed properties, particularly the claimed light transmittance at 632.8 nm.

For example, the system shown in Fig. 1 represents a single crystal pulling chamber which results in the claimed crystal and includes a barrier (13) between a melting heater (5) and the outer edge of crucible (4). In addition, the top of the barrier (13) is higher than the top of the melting heater (5) and a lid member (14) extends between the barrier (13) and the heat insulating wall (6) to close the gap between the barrier (13) and the heat insulating wall (6). The barrier (13) renders the radiation heat from the melting heater (5) more uniform when heating the crucible (4). The lid member (14) prevents heat of the melting heater (5) from escaping upwardly.

The present invention is defined in part by a crystal having a light transmittance of not less than 80% at a wavelength of 632.8 nm. High transmittance is a result of minimal opaqueness on the peripheral surface of the crystal. Such a crystal having high transmittance is not taught or suggested by the prior art of record and would not be inherently produced thereby. The light transmittance (or opaqueness) of the peripheral surface of a single crystal is controlled at least in part by the temperature drop experienced by the crystal surface during its growth. Applicants have discovered that controlling the cooling of a single crystal in the vicinity of the liquid surface of the starting melt material during crystal growth enhances uniformity of the temperature within the vicinity of the liquid surface of the starting melt material. Slower cooling of the melt in growing the crystal results in reduced opaqueness of the crystal surface and greater light transmittance. Applicants have also discovered that a crystal produced by a system such as in Fig. 1 can achieve the claimed transmittance. See page 19, line 13 to page 20, line 13 of the specification.

The claimed feature of high transmittance (not less than 80%) at 632.8 nm cannot be exhibited by the crystals disclosed in the prior art because the processes used to produce those crystals are not effective to control the temperature drop of the crystal surface during its growth.

JP 11-021,197

JP '197 discloses an apparatus employing a single crystal pulling method in Fig. 3. The apparatus includes a heat insulating wall (302) that partially surrounds a melting heater (303). The outer edge of a crucible (304) is exposed directly to the melting heater

(303). No barrier is provided between the melting heater (303) and the outer edge of the crucible (304). The single crystal pulling apparatus method disclosed in JP '197 lacks a structure to control the uniformity of temperature within the vicinity of the liquid surface of the starting material melt. Therefore, the method of pulling a single crystal according to JP '197 cannot control cooling of the starting material melt during the growth of a single crystal in the vicinity of the liquid surface of the starting melt material. Even if a single crystal is produced using the apparatus disclosed in JP '197 by a single crystal pulling method, it is impossible to prevent the peripheral surface of the crystal from being opaque and to obtain an as-grown single crystal having the transparency of the present invention as set forth in claim 1.

The accompanying Declaration Under 37 CFR 1.132 is submitted to demonstrate that not all single crystals pulled in a single crystal pulling apparatus result in a crystal having a transmittance of at least 80% at 632.8 nm. The single crystal pulling apparatus disclosed in JP '197 lacks a barrier between the melting heater and the crucible or other structure that controls cooling of the melt. The accompanying Declaration repeats Examples 1, 4, 7 and 10 of the present application, but without the use of a barrier between the crucible and melting heater. This comparative process mimics the apparatus disclosed in JP '197 in that there is no structure to control cooling of the melt. A comparison of the properties of the resultant crystals produced according to Examples 1, 4, 7 and 10 and Comparative Examples A, B, C and D reported in the accompanying Declaration appears in the following Table.

	Barrier	Barrel diameter (cm)	Barrel length (cm)	Wt. (kg)	Transmittance (%) at 632.8 nm
EX. 1	Yes	28	10	27	93.2
CE A	No	28	6	16.5	72.5
EX. 4	Yes	22	8	16.1	91.5
CE B	No	22	9	17.0	68.5
EX. 7	Yes	28	10	41	94.9
CE C	No	26	9	27	72.1
EX. 10	Yes	26	6	25.6	94.3
CE D	No	26	7	22	70.8

The data for each pair of examples (with a barrier and without a barrier) show that the transmittance at 632.8 nm of crystals that are pulled in a single crystal pulling apparatus without a barrier between the crucible and melting heater is significantly lower than the transmittance of crystals pulled with a barrier. The Office Action asserts that if the rate of pulling a single crystal is slow and the single crystal pulling apparatus includes a structure to prevent heat from the heater from going upwardly into the apparatus, then a single crystal would inherently contain the same light transmittance as presently claimed. This data clearly demonstrates that this is not the case.

The comparative data shows that not all single crystal pulling methods result in a crystal having high transmittance (at least 80%) at 632.8 nm. As such, the product produced according to JP '197 does not anticipate the present invention. The data presented in the Declaration demonstrates that a crystal produced according to a conventional single crystal pulling method as disclosed in JP '197 does not inherently possess the claimed property of high transmittance. Accordingly, claims 1-14 define over JP '197.

<u>U.S. Patent Application No. 2004/009205 to Li et al, U.S. Patent No. 6,332,922 to Sakuma et al. and U.S. Patent No. 6,673,150 to Garibin et al.</u>

Both the Li application and the Garibin patent relate to methods of producing CaF_2 single crystals by a crucible depression method. The Sakuma patent likewise relates to

an annealing process for a CaF_2 single crystal and also only discloses the crucible depression method for producing the single crystal. The crucible depression method (Bridgman's method) is described at page 2, line 15 to page 3, line 15 of the present application.

It is well known that the peripheral surface of a crystal produced via a crucible depression method is opaque. The single crystal is formed in a manner by which the inner wall of the crucible continuously contacts the liquid surface of the starting melt material as the crystal grows. In contrast, in a crystal pulling method, the crystal surface does not contact the crucible during growth. A crystal grown in a crucible depression method becomes opaque and lacks the superior transmittance of the crystals of the present invention.

Copies of the following references are provided herewith to further demonstrate that the crucible depression method is well known to produce opaque crystals:

- Hitachi Chemical Technical Report No. 43, 19-24 (2004-7), with partial translation of section 3.2 on page 21; and
- Technology for Single Crystal Growth Fukuda et al., 1984-2009 (1999).

The partial translation of the Hitachi report describes that an ingot grown in a conventional crucible depression apparatus includes many white particles that are presumed to be CaF_2 single crystals adhering to the surface. This indicates that reaction with the crucible surface has occurred. The peripheral surface of the single crystal obtained by a crucible depression method is necessarily opaque. See Fig. 4 on page 21 of the Hitachi report that shows the peripheral surface of the single crystals obtained by the crucible depression method as being opaque.

Likewise, Fig. 4.1.3 on page 203 of the Fukuda et al. reference also shows that single crystals obtained by the crucible depression method are opaque. Thus, it is well known that the peripheral surface of an as-grown single crystal obtained by a crucible depression method is opaque.

Therefore, none of the Li application, the Sakuma patent or the Garibin patent (relating to crucible depression methods of growing crystals) teach or suggest a technique for producing a crystal by any method which would result in the transparency limitation set forth in claim 1. Accordingly, claims 1, 3, 5 and 10 define over the Li publication and claims 1, 4, 5 and 11 define over the Sakuma patent and the Garibin patent.

Finally, in the absence of any teaching in either the Li application or JP '197, to produce a crystal having the claimed transmittance, the combination of their teachings cannot somehow result in a suggestion to produce a crystal having the claimed transmittance. Accordingly, claims 1-14 define over their combined teachings.

In view of the foregoing and the accompanying Declaration and two references demonstrating the result of employing a crucible depression method for producing crystals, Applicants respectfully request reconsideration of claims 1-14 and allowance thereof.

Respectfully submitted,

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